PREPARED FOR: DEPARTMENT OF SUPPLY AND SERVICES
BUILDING 302, PLEASANTVILLE
ST. JOHN'S, NEWFOUNDLAND
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CONTRACT SERIAL NO. FP001-8-2065/01-XAQ

THE POTENTIAL FOR PRODUCING CAPELIN ROE IN NEWFOUNDLAND AND LABRADOR FOR SALE IN WORLD MARKETS

SUBMITTED TO: FISHERIES DEVELOPMENT DIVISION
DEPARTMENT OF FISHERIES AND OCEANS
P.O. BOX 5667
ST. JOHN'S, NEWFOUNDLAND
A1C 5X1

SUBMITTED BY: THE NEWLANTIC GROUP
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ST. JOHN'S, NEWFOUNDLAND
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FEBRUARY, 1989

The NewLantic Group

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INTRODUCTION

BACKGROUND

Historically, Newfoundland has had a relatively abundant capelin resource. It has been exploited to only a limited extent for use as

- food for human beings and animals,
- bait, and
- fertilizer.

In recent years, the resource has been harvested mainly through an inshore fishing effort during the spawning season, to serve the Japanese market for frozen whole female capelin containing roe. Quotas for the harvest have been established on the basis of prospects for sales to the Japanese buyers, rather than the level of harvesting the resource could support.

Besides the market for roe-in capelin, there has been a market in Japan for roe that have been extracted from capelin. Demand in that market has been served by Iceland and Norway. Efforts by Newfoundland companies to extract capelin roe for sale to Japan have been undertaken only on an experimental basis during the late 1970s.

Capelin harvests in Iceland and Norway have been somewhat erratic over the past few years, leading to concerns about the stability of the resources available to those countries. Newfoundland is currently benefiting from their inability to supply frozen whole female capelin. For the same reasons, it was considered by the Department of Fisheries and Oceans that there might be an opportunity for Newfoundland companies to serve the market for extracted capelin roe.

THIS STUDY

Because of the potential for increased utilization of Newfoundland's capelin resources through extraction of roe, the Department of Supply and Services, on behalf of the Department of Fisheries and Oceans, requested proposals from consulting firms to assess that potential. **The NewLantic Group** was contracted to do the work. Particular objectives for the study were to

- review world markets for extracted capelin roe and determine specifications for products intended to serve those markets,
- identify the resource potential for extracted roe production,
- identify procedures and equipment for roe extraction and processing, along with associated costs, and

- recommend appropriate strategies for development of an industry based on extraction of capelin roe.

For the most part, it was necessary to rely on existing, secondary sources of information in trying to satisfy these objectives. However, such information was supplemented by personal contacts with buyers of capelin roe, suppliers of processing equipment, and Newfoundland companies involved in producing capelin roe on an experimental basis during the late 1970s.

We were particularly fortunate during the study in that another project allowed us to visit Japan and meet with companies involved in importing capelin roe into the country. We were also fortunate in that a representative of an Icelandic company which supplies much of the equipment used to extract capelin roe in both Iceland and Norway visited St. John's and met with us to discuss extraction and processing of the roe.

Our findings are presented in the material that follows.

THE MARKET

WORLD DEMAND FOR ROE PRODUCTS

According to data in the United Nations Food and Agriculture Organization's 1986 "Yearbook of Fishery Statistics", total worldwide imports of fish roes amounted to 56,667 metric tons in 1986, made up of 31,788 tons of fresh, chilled, or frozen roe and 24,879 tons of roe that were dried, salted or in brine. These imports had an overall value of approximately US$391.4 million. That represented substantial growth from 10 years earlier, since imports in 1976 had been 30,530 tons, valued at a bit over US$178.0 million.

One of the most notable aspects of the data in the FAO Yearbook is that Japanese imports accounted for 47,400 tons in 1986, with a value of US$366.2 million - representing over 83% of the total world tonnage and over 93% of the value. Indeed, over the 10 years from 1976 to 1986, Japanese imports grew by 24,423 tons and US$198.8 million, compared with 26,137 tons and US$213.4 million for the world as a whole.

Data showing Japanese imports of fish roes compared to world totals for the 1976-86 period are shown in Table 1. Based on the data, it must be concluded that Japan is by far the most important market for fish roes, both because of the size of its overall demand and because its demand has been growing rapidly.

Sweden is the second largest importer of fish roe products, having imported 4,338 tons in 1986, with a value of US$10.5 million. However, Swedes seem to have little interest in capelin roe. Sweden imported a total of 15 tons of capelin roe from Iceland in 1985.

After Sweden, Denmark is the third largest market for fish roes, followed distantly by the United States, the Republic of Korea, and Thailand.

THE JAPANESE MARKET

Despite the indication provided by the figures above, Japanese imports of roe products may be even larger than was reported by the FAO. "Bill Atkinson's News Report" is a trade newsletter for the fishing industry, based in Seattle. In its November, 1987 edition, the newsletter reported imports of roe products by Japan over the period from 1983 to 1986 as shown in Table 2. These figures are higher than those reported by the FAO. They also illustrate the considerable variety of such products available in Japan. However, the table does not list capelin roe as one of the products.

During the period for which data are provided in Table 1, practically all of the growth in imports by Japan was in the fresh, chilled, and frozen category, rather than in roe that were

TABLE 1
JAPANESE IMPORTS OF FISH ROES
COMPARED TO WORLD TOTALS

	WORLD TOTAL		JAPAN		JAPAN AS % OF TOTAL	
YEAR	METRIC TONS	$000 US	METRIC TONS	$000 US	METRIC TONS	$000 US
Fresh, Chilled, Frozen						
1986	31788	155698	26352	140566	82.9	90.3
1985	28695	101618	23712	87759	82.6	86.4
1984	23907	78838	19342	65435	80.9	83.0
1983	18582	63268	14760	51578	79.4	81.5
1982	35909	67369	13213	54193	36.8	80.4
1981	11247	39625	7296	27637	64.9	69.7
1980	12414	31563	7518	20809	60.6	65.9
1979	13393	40414	9147	32197	68.3	79.7
1978	9915	19096	4434	13121	44.7	68.7
1977	7362	10981	3728	6339	50.6	57.7
1976	8425	10543	4504	5592	53.5	53.0
Dried, Salted, or In Brine						
1986	24879	235724	21048	225586	84.6	95.7
1985	26739	245862	23176	239556	86.7	97.4
1984	24707	210627	20982	204407	84.9	97.0
1983	28103	253612	24278	247385	86.4	97.5
1982	30543	271566	26808	263756	87.8	97.1
1981	27910	281308	23524	271052	84.3	96.4
1980	23029	198355	18269	187777	79.3	94.7
1979	28149	416114	24031	408296	85.4	98.1
1978	25588	304010	20804	295346	81.3	97.2
1977	23122	210232	18701	202367	80.9	96.3
1976	22105	167470	18473	161711	83.6	96.6
Combined						
1986	56667	391422	47400	366152	83.6	93.5
1985	55434	347480	46888	327315	84.6	94.2
1984	48614	289465	40324	269842	82.9	93.2
1983	46685	316880	39038	298963	83.6	94.3
1982	66452	338935	40021	317949	60.2	93.8
1981	39157	320933	30820	298689	78.7	93.1
1980	35443	229918	25787	208586	72.8	90.7
1979	41542	456528	33178	440493	79.9	96.5
1978	35503	323106	25238	308467	71.1	95.5
1977	30484	221213	22429	208706	73.6	94.3
1976	30530	178013	22977	167303	75.3	94.0

SOURCE: FAO Yearbook of Fishery Statistics.

TABLE 2
JAPANESE ROE IMPORTS, 1983-86
METRIC TONS

ITEM/SOURCE	STYLE	1986	1985	1984	1983
Herring Roe					
-Canada	Frozen	5271	4652	2918	1493
-Other	Frozen	1626	845	311	223
-Canada	Salted	2867	4001	4684	5369
-United States	Salted	781	1626	878	1247
-Korea	Salted	1124	830	375	336
-Other	Salted	1990	1226	1372	1676
Total Herring Roe		13659	13180	10538	10344
Herring Roe on Kelp		403	250	356	507
Salmon Roe					
-United States	Salted	7713	8758	8544	8098
-Others	Salted	1812	1463	662	684
Total Salmon Roe		9525	10221	9206	8782
Pollock Roe					
-United States	Frozen	6644	6251	4782	1937
-Soviet Union	Frozen	5252	5123	5117	3915
-South Korea	Frozen	7100	6322	5199	4148
-Others	Frozen	1304	830	1015	3024
-South Korea	Salted	892	1279	1297	2227
-North Korea	Salted	2118	2242	1979	3321
-Others	Salted	590	981	374	304
Total Pollock Roe		23900	23028	19763	18876
Seasoned Herring/Pollock Roe					
-South Korea		3099	2371	1259	391
-North Korea		1375	1751	5810	4123
-China		504	0	6	0
-Others		8	0	0	101
Total Seasoned		4986	4122	7075	4615
Others		758	520	461	509
		53231	51321	47399	43633

SOURCE: Bill Atkinson's News Report, November 25, 1987

dried, salted, or in brine. This constituted a major change in the mix of products, since imports of the dried/salted/brined products were over 2.6 times those of fresh, chilled, and frozen products in 1976. This change shown in the FAO data seems to be confirmed in the data from Bill Atkinson's News Report.

In addition to being the world's largest market for imported fish roes, Japan is also a major producer of them. Table 3 shows Japanese production of the major roe products from 1976 to 1986, as reported in the FAO Yearbook. As can be seen from the data, Japan's own production of roe products grew quite substantially over the period. However, it seems likely that simply adding Japanese domestic production to imports would result in some double counting, because some of the roe imported are processed in Japan prior to sale.

Since little or none of Japan's roe products seem to have been exported, it appears that Japanese consumption of roe products is quite high, probably higher than that of any other country. In addition to the roe itself, fish containing roe - such as the female capelin imported from Newfoundland - are also very popular items. Visits to a considerable number of food stores in Tokyo confirmed that these products are widely available in both quantity and variety.

From the data in Table 3, it seems that pickled Alaskan pollock roe represents the largest volume roe product and has held that position for some time. Herring roe is second, followed by salmon roe, production of which showed particularly rapid growth over the 1976-86 period. Production of herring roe decreased from 1976 to 1979 and then began to increase again toward 1976 levels. This pattern is particularly significant, because capelin roe is generally considered by Japanese consumers to be a lower-cost substitute for herring roe.

The decrease in herring roe production was due to a drop in the domestic Japanese herring catch. In the early part of the 20th century, Japan's yearly herring landings peaked at about 670,000 tons before World War I. After that, landings began to drop, falling to about 150,000 tons annually in the early 1950s and reaching a low of 6,708 tons in 1978.

According to the worldwide marketing study prepared by the Department of Fisheries and Oceans in 1979 and revised in the early 1980s,

> "The decline prior to 1976 was attributed to overfishing, changes in water currents and the closure of fishing in the Sea of Okhotsk by the USSR. Further declines occurred after 1976 as a result of extended fishing jurisdictions in the North Pacific. ...With the drop in Japan's domestic catch, supplies of herring roe declined because of import quotas,

TABLE 3
JAPANESE PRODUCTION OF ROE PRODUCTS, METRIC TONS

YEAR	SALMON CURED	ALASKAN POLLOCK PICKLED	HERRING DRIED	HERRING CURED
1986	8334	57162	0	12799
1985	9058	55364	0	11592
1984	7106	50714	0	10737
1983	6764	45994	0	9597
1982	6327	41866	0	8697
1981	5302	41777	0	8554
1980	4169	32249	5	7702
1979	4799	24975	23	5615
1978	3036	23000	20	9500
1977	2864	36420	16	9958
1976	2068	40603	32	12055

SOURCE: FAO Yearbook of Fishery Statistics.

which were in effect for roe and frozen herring. In the 1960s the tight supply situation caused prices to rise as high as 6500 yen per kilogram at the Tokyo Central Wholesale Market, making roe a luxury product. The import quota was removed in 1972, and large volumes of imports began to come into the country."

That report goes on to say that,

"Coinciding with the liberalization of import quotas for herring roe in Japan, the herring fishery in British Columbia expanded to capitalize on the lucrative market. From 1975 to 1979, BC was the largest supplier of roe to Japan, accounting for 73% of imports. ...After 1976, landings were steadily cut back by fisheries management, to a catch of 26,000 tonnes in 1982, because of declining herring stocks. However the average landed price to BC fishermen increased gradually over the period from 1972 to 1977 from C$56 per short ton; to C$350 per ton; in 1978 the price more than doubled to C$732 and in 1979 it quadrupled from the previous year to attain an average of C$2,975 per short ton.

Japanese imports of herring roe reached a high of 12,867 tonnes in 1976 and have declined since then to 8,220 tonnes in 1979, 6000 tonnes in 1980 and 7,600 tonnes in 1981. Supplies from the US, China and Korea were relatively stable in these years, while the decline in total imports was reflected by smaller landings of herring in BC. As the availability of herring roe declined in Japan, prices moved up gradually in 1976, 1977 and 1978, but nearly doubled from 1978 to 1979. ...The rapid price change of herring roe in BC was caused not only by the shortage in Japan, but also the decline in the value of the Canadian dollar vis a vis the yen: from an average of 300 yen per dollar in 1976 to 251 yen per dollar in 1977 and 182 yen per dollar in 1978.

...Meanwhile, Japanese wholesale prices for large-size roe increased from 8,500 yen per kilogram in April to a peak of 14,000 yen per kg in December 1979 at least in part to speculative bidding. The Japanese news media reacted with vigorous criticism of this speculation, and as a result consumers boycotted herring roe during the New Year's holiday season, causing prices to plunge and leaving the trading companies with nearly 4,000 tonnes of roe to be carried over in inventory into 1980.

To make matters worse, in December of 1979 the Japanese Ministry of Health announced research findings indicating that the hydrogen peroxide used in bleaching herring roe could be a contributing cause of cancer, and said steps would be taken in the coming year to prevent its use.

> ...The actual consumption of roe in 1980 was approximately 9,000 tonnes - up about 3,000 tonnes from the previous year but substantially lower than in years prior to 1979. In 1981 roe consumption increased to the 12,000 tonne level due to (1) attractive prices to consumers (2) sales promotion by importers and processors and (3) concerted merchandising efforts by the trade.
>
> As of October 1, 1980, the Japanese Ministry of Health changed the regulation governing the use of hydrogen peroxide in herring roe to require that the finished product must indicate that it had been treated. Most processors have been able to bleach by developing methods to meet the zero residue specifications, but consumers may harbour lingering doubts that continue to have an impact on the market."

It was in this generally tumultuous supply and demand situation that Newfoundland companies began experiments with production of capelin roe in the late 1970s. However, they were not the only ones trying to offer Japanese consumers an alternative supply of roe. As was indicated above, Canadian production of herring roe expanded initially to serve the demand. In addition, United States production expanded from 1,202 tonnes in 1976 to 1,768 tonnes in 1981.

The Japanese were accustomed to roe from Pacific herring. However, because it was available to them in ever decreasing and more expensive quantities, roe from Atlantic herring was an alternative to be considered. Approximately 48 tonnes were produced in Atlantic Canada in 1977, valued at C$274,000. In 1978, production increased to 79 tonnes, valued at C$609,000. At that stage, the roe was produced as a by-product of herring filleting operations.

Since then, the industry in Atlantic Canada has developed further, so that roe is now the principal product at many plants. Indeed, demand for herring fillets from Atlantic Canada decreased, as domestic production by European countries increased during the early 1980s. Furthermore, with the increase in herring catches in Europe, countries harvesting Atlantic herring in Northern Europe have also been supplying extracted roe to Japan.

According to the February 10, 1988 issue of "Bill Atkinson's News Report", Japan's herring roe supply has been steadily increasing since 1980, primarily due to growth in the supply of roe from Atlantic herring but also due to an increase in production from the Canadian Pacific fishery.

According to the newsletter,

"While the numbers for December are not finalized yet, it appears that more than 23,000 tons of herring roe suitable to be processed and sold as 'kazunoko' was produced during 1987. If the carry-over inventory from 1986 is also taken into consideration, the total supply for the year is estimated at about 27,810 tons. This makes the supply of herring roe second only to pollock roe on the roe market in Japan.

The high volume of herring roe is largely due to excessive efforts to develop sources of roe for the salted and flavored herring roe markets in Japan. ...

Roughly 13,000 tons of the herring roe supply is processed into the traditional salted herring roe - bleached 12,250 tons/without bleach 600 tons - with almost 15,000 tons used for flavored roe. ...

While the final figures have not been announced, it appears that about 1,500 tons of roe have been carried over into this year (some estimates place the carry-over as high as 3,000 tons). This means that about 11,500 tons of herring roe was sold and consumed during 1987 - 1,500 tons to restaurants during the year and 10,000 tons during the year-end gift sales season."

Atlantic herring roe is not regarded as favorably by the Japanese as Pacific herring roe. The membrane in Atlantic roe is thinner, so it is easier to break and it does not keep its shape as well. Atlantic roe also is not as crunchy as Pacific roe. For these reasons, it has been used in less demanding applications, such as in the preparation of products containing loose herring eggs and in production of flavored herring roe products.

Fortunately, demand for flavored products has grown, apparently due to their flavor, convenience, and reasonable prices, since the price paid for Atlantic roe has been considerably lower than that paid for Pacific roe. Furthermore, sales are more continuous throughout the year than those of salted herring roe, although they do peak in July/August and at the end of the year. The salted roe, made from the roe of Pacific herring, must be leached before use, while flavored roe, made from the roe of Atlantic herring, can be used straight from the pack and apparently suits the taste of the younger people.

Japanese imports of herring roe from Atlantic Canada increased fairly steadily from about 1,000 tons in 1982 to about 6,000 tons in 1986. Imports from European suppliers grew from about 200 tons in 1983 to about 1,000 tons in 1986. In both cases, this was attributed to the popularity of the flavored herring roe. However, the growth in demand also brought in new buyers and drove prices up in 1986, beyond the level that processors

believed the market could stand.

The issue of Bill Atkinson's News Report quoted above listed ex-importer prices for raw herring roe from different sources during 1987 as follows:

- Pacific Canadian roe, ¥4,600/kilo (US$16.46/lb. @ ¥127/US$),
- Bristol Bay (Alaska) roe, ¥4,000/kilo (US$14.32/lb.),
- Northern European roe, ¥2,100/kilo (US$7.52/lb.).

These prices apparently were considered reasonable and processors were confident that finished roe could be sold at competitive wholesale and retail price levels. However, as the end of 1987 approached, it became clear that sales of Bristol Bay and European roe were not proceeding as well as expected. As a result, processors came to feel that the wholesale prices for finished roe should have been set lower.

In July, 1988, the market was unsettled again as a result of a report that some 'kazunoko' contaminated with high levels of hydrogen peroxide was shipped to Japanese consumer markets by a Hokkaido processor late in 1987. Sales were affected once more toward the end of 1988, due to the illness and subsequent death of Japan's Emperor.

In the January 1, 1989 edition of the "Sou'Wester", an Atlantic Canadian newspaper devoted to news related to the fishing industry, one Atlantic Canadian processor of herring roe reported that his Japanese client still had 3-4,000 tons of roe left in inventory at the end of 1988 and that prices were down about 20% from 1987 levels. He felt that the local industry would be doing well in 1989 if 1988 prices could be maintained. He observed that, although the market for roe is expanding, world production of it is expanding at a greater rate. For the foreseeable future, he considered it likely that there would be a "soft" or "buyer's" market.

Although it was not possible to obtain complete data on worldwide herring roe production, one indication that these observations are correct, is in the quantities of herring landings, as contained in the FAO's 1986 "Yearbook of Fishery Statistics", which are shown in Table 4. As may be seen from the data, total landings of Pacific herring expanded from 224,613 metric tons in 1982 to 324,843 metric tons in 1986, while landings of Atlantic herring grew from 983,408 metric tons to 1,536,291 metric tons over the same period.

In addition to herring roe itself, there has been an ongoing market in Japan for herring roe layered on kelp. This product was first imported from Alaska in 1962. According to DFO's

TABLE 4
HERRING LANDINGS, METRIC TONS

SPECIES/COUNTRY	FISHING AREA	1986	1985	1984	1983	1982
ATLANTIC HERRING						
Canada	21	177830	188595	132592	142454	147251
Cuba	21	53	6	0	0	1
Greenland	21	5	1	5	10	26
Japan	21	2	0	0	0	0
Poland	21	0	8	0	0	0
USSR	21	508	58	0	3	10
USA	21	36007	25915	33468	23253	33084
Area Total	21	214405	214583	166065	165720	180372
Belgium	27	415	3482	5080	5970	10090
Denmark	27	150464	111380	117509	173861	83714
Faeroe Islands	27	2020	668	2461	1600	1134
Finland	27	98999	98999	97408	95890	85000
France	27	14582	14667	22429	16755	15143
German Dem Rep	27	53061	51607	50072	51990	50868
Fed Rep Germany	27	15525	23946	25338	17083	17637
Iceland	27	65756	49363	49747	58867	56528
Ireland	27	38020	31978	31623	32025	29743
Netherlands	27	101966	98211	56280	55929	35188
Norway	27	324479	239369	157945	68224	40044
Poland	27	77109	85865	78326	82329	76329
Sweden	27	120734	135128	158634	158917	150446
USSR	27	141954	166841	106440	112911	100064
UK England, Wales	27	5676	11377	1876	848	4978
UK Scotland	27	106727	90682	73669	53133	42831
UK N. Ireland	27	3601	2616	1777	1989	2263
UK Isle of Man	27	798	857	1106	797	1036
Area Total	27	1321886	1217036	1037720	989118	803036
Species Total		1536291	1431619	1203785	1154838	983408
PACIFIC HERRING						
China	61	6445	3228	9444	21267	23464
Japan	61	72741	9193	6760	8360	24197
Korea Rep	61	1386	773	497	544	661
USSR	61	168356	189584	150161	132892	89032
Area Total	61	248928	202778	166862	163063	137354
Canada	67	16600	25500	33703	39820	28598
USA	67	51764	56549	43730	50643	48664
Area Total	67	68364	82049	77433	90463	77262
USA	77	7551	7896	3781	7978	9997
Species Total		324843	292723	248076	261504	224613

TABLE 4
HERRING LANDINGS, METRIC TONS (CONTINUED)

NOTES:
1. Area 21 is the Northwest Atlantic.
2. Area 27 is the Northeast Atlantic.
3. Area 61 is the Northwest Pacific.
4. Area 67 is the Northeast Pacific.
5. Area 77 is the Eastern Central Pacific.

SOURCE: FAO Yearbook of Fishery Statistics

"Worldwide Fisheries Marketing Study", demand ranged from 357 tonnes in 1978 to 544 tonnes in 1980. Bill Atkinson's News Report, in its November 25, 1987 edition, reported that herring roe on kelp imports were 507 tonnes in 1983, 356 tonnes in 1984, 250 tonnes in 1985, and 403 tonnes in 1986. During the 1988 Pacific Canadian herring roe season, prices varied between a lowof C$25.00/lb. to a high of C$35.10/lb., depending on the quality of the product.

THE POTENTIAL FOR CAPELIN ROE

As was noted above, capelin roe has been regarded by Japanese consumers as a lower cost alternative to herring roe. As such, there has been an ongoing market in Japan for capelin roe, which has been supplied primarily by Norway and Iceland. Table 5 provides a summary of capelin roe imports by Japan over the period from 1978 to 1987, according to data assembled from various sources.

These data show that the quantities imported, the sources of supply, and the purchase prices have all fluctuated considerably over the period covered. Both Norway and Iceland have had problems with variable resource availability, affecting their ability to supply the Japanese with capelin roe. In particular, during 1987 and 1988, there was no fishing for capelin in the Barents Sea - a key area for spawning capelin - as a result of an agreement between Norway and the Soviet Union.

The lack of supply from Norway seems to have driven up the price obtained by Iceland in 1987. It was believed that production facilities in Iceland had capacity to produce only about 6,000 tons, less than the quantity imported by Japan in the previous year. That seems to have been borne out by the data in Table 5, which shows that 6,200 tons were imported from Iceland in 1987, even with the very favorable price.

In 1988, Iceland suffered poor capelin catches, resulting in a drop in the quantity of roe supplied to a level reported by Japanese buyers to be in the range of 2-3,000 metric tons. Regardless, the price paid by Japanese buyers of capelin roe also dropped. Packers were reportedly asking for US$1,950/ton - the equivalent of a Japanese wholesale price of ¥340/kilo (US$1.21/lb.) However, the buyers refused to pay that much, because the market was weak, with a heavy carry-over of inventory from the previous year, and prevailing wholesale market prices were ¥300/kilo (US$1.07/lb.) Instead, they offered US$1,500 to 1,700/ton.

According to Japanese buyers of capelin roe with whom discussions were held during this study, demand continues to be very weak in 1989, due to the effects of the strong availability of herring roe and the weak market conditions for that product, as well.

TABLE 5
JAPANESE IMPORTS OF CAPELIN ROE, METRIC TONS

YEAR	NORWAY	ICELAND	USSR	CANADA	TOTAL	PRICE, US$/TON	IMPORT VALUE US$
1987	0	6200	0	0	6200	2450	15190000
1986	4800	3200	0	0	8000	1750	14000000
1985	3700	1251	0	0	4951	N/A	N/A
1984	8000	1857	0	0	N/A	1900	N/A
1983	7600	0	0	0	7600	2100	15960000
1982	3680	309	0	0	3989	1750	6980750
1981	1740	2097	0	0	3837	1650	6331050
1980	583	633	194	15	1425	1450	2066250
1979	831	3565	300	0	4696	2400	11270400
1978	10	2350	0	0	2360	1750	4130000

SOURCE: Some data assembled by Edwin Wells of the Fisheries Commerce Unit from various sources, as follows:

1. Capelin Mission to Japan, January 17-21, 1983
2. Globefish Highlights, "Fish Roe", Food and Agriculture Organization of the United Nations, September 15, 1987, p. 42
3. Marine Research Institute, Reykjavik, Iceland
4. Canada Post Telex from Tokyo, March 11, 1987

Other data taken from a report entitled, "A Long-Term Utilization Strategy for Newfoundland Capelin Resources", by IDP Consultants Limited, dated March, 1986.

Furthermore, it was reported that the Icelandic roe capelin fishery underway as of February, 1989 was producing only small capelin. It was expected that roe production from that fishery would be in the same low range as in 1988 and that prices would similarly remain at relatively low levels.

A few years ago, it was attempted to produce a "formed" herring roe product as an inexpensive substitute for salted herring roe. The product was a combination of pollock surimi and capelin roe that was formed into a herring roe shape. Initially, the product was popular and more than 100 companies rushed to make it. However, the boom was short-lived and the number of processors is now quite small. Those that remain are concentrating their efforts on development of new markets for their products, particularly among inexpensive sushi restaurants and for use in salads.

In 1986, it was reported that capelin roe had become increasingly popular for use in seasoned roe products and at sushi bars, due to reasonable prices and good flavor. Companies producing seasoned roe products switched to capelin roe, when prices for flying fish roe went too high and it proved to be a popular replacement. However, the initial success waned after the limited supply and high prices of capelin roe in 1987 prompted the companies producing seasoned roe to look again for lower-cost alternatives.

Another attempt to market capelin roe was undertaken by Goshoku Company, which produced a capelin-egg sausage, consisting of capelin eggs packed in a plant protein casing. These sausages were 30 gm. each, were packed individually, and were sold at a suggested retail price of ¥150/pack. It was reported that the product was low in salt and sugar and had a texture comparable to herring roe but without the "bitterness". No data are available on sales of the product but they do not seem to have been sufficient to save capelin roe from its present sales slump.

During this study, we talked with several Japanese buyers or prospective buyers of capelin roe. None of these people offered much encouragement related to the potential for Newfoundland companies to enter the market with roe, because of the reasons outlined above and for other reasons, as well.

One buyer of female capelin in Newfoundland, whose company buys capelin roe in Iceland and Norway, made a number of observations, as follows:

1. of the fish roes available to Japanese consumers, capelin roe ranks fourth in order of preference, behind roes from salmon, herring, and cod (i.e. Pacific cod);

2. the market for extracted roe is very unstable and weak at

the present time;

3. Norway and/or Iceland have the capacity, with state-of-the-art production equipment, to supply the demand in Japan for the product and, even with the current moratorium on capelin fishing in Norway, market demand can easily be met by Icelandic companies;

4. Japanese buyers are satisfied with the products they receive from both Iceland and Norway and would be very reluctant to import such a delicate product from Newfoundland, because Newfoundland companies have a tendency not to abide by the specifications set down for them;

5. there is a perception among the Japanese that Norway, in particular, has the expertise needed for handling delicate products like extracted roe, so that, Newfoundland companies would likely have to bring in the expertise from Norway; and

6. he understands that Japanese buyers lose a great deal of money handling this product.

While this was not encouraging, he went on to say that, for the most part, the younger generation of Japanese either cannot distinguish cheaper, imitation products from the higher quality salmon and herring roes or simply don't care about the differences between them. Consequently, a great deal of work in development of new roe-based products, coupled with a willingness by the younger generation to accept new products, could possibly mean a much larger market for capelin roe in the future.

His conclusion was that, if he were a Newfoundland processor, he would get involved in processing capelin roe only on an experimental basis, with a large amount of financial assistance from government.

Other buyers made comments similar in many respects to those outlined above. One also noted that the younger generation of Japanese are not particularly fond of fish roes and that, at one point, consumption of herring roe was decreasing, because the younger people were not fond of the traditional salted herring roe product. However, when a newer, pickled roe product was introduced, sales increased dramatically.

Continued problems with availability of capelin roe from their traditional suppliers may lead Japanese buyers to look to Newfoundland to satisfy the limited demand that presently exists. Indeed, one Japanese buyer of Newfoundland's female capelin indicated that he had encouraged some of his suppliers to produce small quantities of roe on an experimental basis during 1988. However, there was no interest in taking him up on his offer to buy it.

Another buyer recounted that, about three years ago, he had attempted to encourage some of his Newfoundland suppliers of female capelin to supply him with some roe, as well. The attempt was not successful, apparently because fishermen did not want to spend the extra time needed to handle the roe. Instead, they simply wanted to unload their catch of capelin and return to fishing as quickly as possible.

AVAILABILITY OF RAW MATERIAL

THE RESOURCE

Capelin are a cold water, pelagic, schooling fish species inhabiting Arctic and sub-Arctic waters in both the Atlantic and Pacific Oceans. According to a publication on capelin in the Department of Fisheries and Oceans "Underwater World" series, Atlantic and Pacific capelin were once thought to be different species but they are now considered to be the same, with the Latin name Mallotus villosus.

In the Pacific, they can be located off the coast of Alaska and South to Japan and Korea. On the Eastern perimeter of the Atlantic Ocean, they can be found from Western Norway to Northern Russia but are particularly abundant in the Barents Sea and off the coast of Iceland. On the Atlantic's Western perimeter, they can be found from Hudson's Bay to Nova Scotia but the major concentrations occur off the coast of Newfoundland and Labrador.

Although there are exceptions, most capelin spend the bulk of their lives offshore, coming inshore only to spawn. It is during their spawning migration that they are now harvested to be processed for the Japanese market for roe-in female capelin. Harvesting for production of capelin roe would also have to take place during the same period.

Five major capelin stocks have been identified in areas near Newfoundland and Labrador, as follows:

1. Labrador-Northeast Newfoundland stock, in Northwest Atlantic Fisheries Organization area 2J3K;

2. Northern Grand Bank-Avalon stock, in NAFO area 3L;

3. South Grand Banks-Southeast Shoal stock, in NAFO area 3NO;

4. St. Pierre-Green Bank stock, in NAFO area 3Ps; and

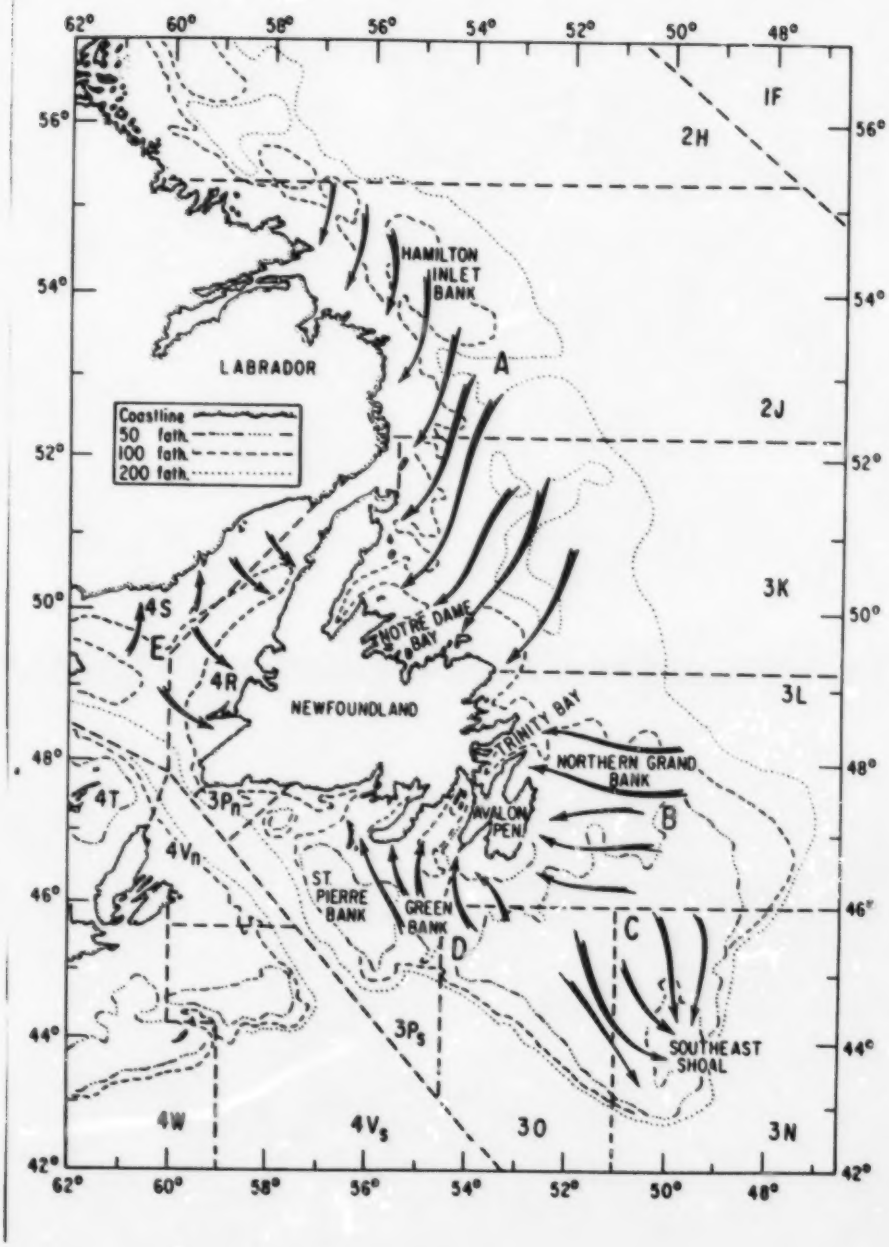
5. Gulf of St. Lawrence stock, in NAFO area 4RST.

Figure 1 shows these major stocks, labelled A to E, and their probable routes during their spawning migration. Capelin that migrate for spawning are almost exclusively three or four years old.

Spawning is a function of water temperature and occurs at different times in different areas. In Northern Europe, it occurs in February and March but, in Canadian waters, it generally occurs much later.

In the Gulf of St. Lawrence, spawning may occur as early as April in areas near the St. Lawrence River and it then proceeds downstream, occurring on the North Shore in June. On the West

FIGURE 1


62°
60°
58°
56°
54°
52°
50°
48°
56°
54°
52°
50°
48°
42°
1F
2H
2J
3K
3L
3N
3O
3Pn
3Ps
4R
4S
4T
4Vn
4Vs
4W
A
B
C
D
E
LABRADOR
HAMILTON INLET BANK
NOTRE DAME BAY
NEWFOUNDLAND
TRINITY BAY
NORTHERN GRAND BANK
AVALON PEN.
ST. PIERRE BANK
GREEN BANK
SOUTHEAST SHOAL
Coastline
50 fath.
100 fath.
200 fath.

and South coasts of Newfoundland, spawning usually begins in late May and is progressively later farther North. In Northeastern and Southeastern Newfoundland - presently the areas with the major commercial capelin fisheries - and on the Southeast Shoal, spawning occurs in June and July. Spawning in Labrador may not occur until August.

During the spawning season, males and females form separate schools but they converge on the beaches, where eggs are laid and fertilized. After spawning, most capelin die, so they no longer have any potential for commercial exploitation.

Capelin are considered to be the most important forage fish in the Northwest Atlantic, being food for many commercially important fish species, including cod, haddock, winter flounder, Atlantic salmon, and Atlantic herring. However, they are food for other species, as well, including whales and harp seals.

Because of their role as a forage fish, capelin play an important part in the seasonal inshore fishery. As they migrate inshore to spawn, cod follow them and, thereby, become available to be caught by traps set near the shore.

QUOTAS

Management of the capelin resource for commercial purposes presents some difficult problems. The total biomass of the stock can undergo large annual fluctuations but, because the fish are still relatively young when they reach maturity, it is difficult to estimate the size of the stock.

Some people believe the capelin resource should not be fished at all, due to its importance as a forage fish. On the other hand, it has now become a major factor determining the commercial viability of many fishermen and fish processing companies. As well, there have been studies indicating that changes in the abundance of capelin do not have much effect on the abundance of predator species.

Capelin have been harvested inshore by people in Newfoundland for generations, mainly for their own use as bait, fertilizer, and - to a limited extent - food. Catching them for commercial purposes is a relatively recent development. Average annual catches by Canadian vessels ranged from 2,000 to 4,000 tons during the period from 1966 to 1972 and peaked for the 1970s at 22,093 tons in 1979. The first substantial offshore catches by foreign vessels were in 1972, when about 70,000 tons were harvested. Offshore catches then increased rapidly to a peak in 1975 of about 360,000 tons.

Catch quotas were first established for capelin in Canadian waters in 1974, when a quota of 250,000 tons was allowed. This

increased to 500,000 tons in 1975 but drastic reductions were put into effect in 1979, due to evidence of poor recruitment. The capelin fishery on the Grand Banks was closed to offshore fleets and a Total Allowable Catch was imposed on the inshore fishery in NAFO area 3L. At about the same time, inshore fishermen began catching capelin during the spawning season to supply the Japanese market for roe-in female capelin.

Total Allowable Catches established by fisheries scientists over the past few years, based on biological assessments, are outlined in Table 6. On the other hand, actual fishing quotas have been established at much lower levels, primarily on the basis of expected market demand for capelin. These are also included in Table 6. Fishing quotas have also been established by gear type and region - generally, a bay - considering a number of factors, including resource availability, licences, and production capacity.

Some allowance is made in the setting of quotas for an offshore fishery by foreign vessels. However, there has been a policy of restricting these vessels from catching capelin during the spawning season. Consequently, the offshore catches in NAFO area 2J3K represent capelin harvested by vessels from the USSR during the Fall.

From Table 6, it can be seen that the Total Allowable Catches set by the Department of Fisheries and Oceans have been considerably lower than they might have been, according to the advice of the biologists who monitor the size of the resource. In general, actual catches have been even lower than the catches allowed. As a result, it seems fair to conclude that the resource could support a larger harvesting effort than it has been subjected to in recent years.

THE HARVESTING EFFORT

According to a report by Mr. Raymond Andrews, Deputy Minister of Fisheries for the Province of Newfoundland and Labrador, entitled "The Capelin Fishery - Stability in the Future",

> "Well over 90% of all capelin harvested are processed into meal and oil products. This is especially true for Norway and Iceland, which have huge industrial fisheries for capelin. Consequently, the production of female capelin (shishamo), or extracted capelin roe, for the Japanese market, is a relatively minor by-product of overall capelin processing activity. The reverse is true in Canada (Newfoundland) where the capelin fishery is directed almost exclusively to the production of female capelin for the Japanese market with very limited meal and oil production and no extracted roe processing in recent years."

TABLE 6
COMPARISON OF ALLOWABLE CATCHES WITH ACTUAL CATCHES
METRIC TONS

YEAR	2J3K		3L	3Ps	3NO	4R	TOTAL
BIOLOGICAL TOTAL ALLOWABLE CATCHES							
1988	41000		90000	No Advice	10000	No Advice	N/A
1987	73000		283000	2000	10000	10000	378000
1986	36000		130000	2000	0	10000	178000
1985	25000		60000	1000	0	10000	96000
1984	25000		38000	1000	0	10000	74000
1983	22000		60000	0	0	10000	92000
SET TOTAL ALLOWABLE CATCHES							
	INSHORE	OFFSHORE					
1988	23000	17000	44600	3400	15000	5300	108300
1987	8600	31000	24600	1300	10000	5000	80500
1986	19000	17000	55000	2000	0	6000	99000
1985	8000	17000	26000	1000	0	3700	55700
1984	8000	17000	26000	1000	0	9000	61000
1983	11000	10000	30000	1000	0	7000	59000
CATCHES							
1988	26505	17000	52865	3203	5000	4387	108960
1987	8940	27000	22436	250	1000	906	60532
1986	11802	17000	48428	2307	0	3764	83301
1985	7368	17000	25450	98	0	2617	52533
1984	7118	17000	33260	1140	0	1906	60424
1983	3768	10000	25074	146	0	920	39908

SOURCE: Department of Fisheries and Oceans

World capelin landings for the period from 1982 to 1986 are shown in Table 7, by fishing area and country. According to these data, 1,461,094 metric tons were landed in 1986, which represented a considerable reduction from levels achieved in previous years. All of this reduction occurred in the Northeast Atlantic, with Norway and the USSR suffering most, due to the cessation of fishing in the Barents Sea.

Canadian landings represented only a little more than 4.5% of the world total in 1986 but that was up from about 1.6% in 1985. Indeed, until 1988, 1986 was the best year ever for Canadian catches of capelin, because of the very strong demand and good prices in that year for our frozen roe-in female capelin in Japan. That demand was largely attributable to the inability of the other countries to supply the market.

Most of the Canadian landings have occurred in NAFO area 3L, near the Southeastern part of the Island of Newfoundland. Significant catches have also been made in area 2J3K, adjacent to the Northeastern part. However, some of the catches in 2J3K have been through an offshore effort by foreign vessels. Small quantities have also been landed in area 4ST, mainly by Quebec fishermen.

According to the report by Mr. Raymond Andrews referred to above,

> "The inshore capelin fishery is pursued by two fleet sectors, i.e. fixed and mobile. The fixed gear activity is generally conducted in boats of less than 45 ft. Indeed, many of them are less than 30 ft. and the principal gears used are capelin traps and bar seines. Mobile gear activity is generally conducted from boats 45 ft. - 65 ft. in length, using purse seines. There are also a small number of larger purse seiners, generally 80 - 100 feet, and operating in the Gulf of St. Lawrence, i.e. Area 4R.
>
> Licences to prosecute the capelin fishery are available to fulltime fishermen only, having been restricted to this group in the early 1980's. As can be appreciated, because the fishery developed mainly in 3L until 1986-1987, the number of licences in that area was considerably higher than that for the remainder of the Province. However, during the last year or two a considerable number of fixed gear licences have been issued in 3K and now the total number of licences compares with the 3L portion of the Province. ...
>
> Mobile gear licences have remained fairly static, both in numbers and distribution throughout the Province."

The numbers of licences, by type and NAFO area, are presented in Table 8.

TABLE 7
WORLD CAPELIN LANDINGS, METRIC TONS

COUNTRY	FISHING AREA	1986	1985	1984	1983	1982
Canada	21	66031	35123	43605	29939	31838
Cuba	21	0	3	0	0	0
Greenland	21	1067	980	1069	288	104
St. Pierre/ Miquelon	21	0	0	12	10	33
USSR	21	16757	16838	17366	10497	9677
Area Total	21	83855	52944	62052	40734	41652
Denmark	27	5381	7460	7867	0	17959
Faeroe Islands	27	65435	83250	45304	36466	21300
France	27	0	0	0	0	3
Greenland	27	54377	55961	7	8	2
Iceland	27	898013	993437	867492	133478	13257
Norway	27	271543	640810	945567	1492672	1152945
Portugal	27	7	0	0	0	0
USSR	27	51215	398060	627855	846486	596482
Area Total	27	1345971	2178978	2494092	2509110	1801948
USSR	61	31268	30790	38984	3547	1039
Species Total		1461094	2262712	2595128	2553391	1844639

NOTES: 1. Area 21 is the Northwest Atlantic.
2. Area 27 is the Northeast Atlantic.
3. Area 61 is the Northwest Pacific.

SOURCE: 1986 FAO Yearbook of Fishery Statistics

TABLE 8
FISHING LICENCES

YEAR	2J	3K	3L	3Ps	4R	TOTAL
FIXED GEAR						
1988	15	1066	973	147	331	2532
1987	10	920	896	133	180	2139
1986	4	771	707	100	133	1715
1985	1	269	426	43	69	808
1984	2	268	439	48	0	757
1983	2	213	432	25	0	672
MOBILE GEAR						
1988	0	78	150	5	18	251
1987	0	61	136	5	17	219
1986	0	64	145	7	17	233
1985	0	51	133	7	9	200
1984	0	49	134	7	8	198
1983	0	43	138	5	6	192

SOURCE: Ray Andrews, "The Capelin Fishery - Stability in the Future" supplemented by information from DFO.

Table 9 shows catch rates for both traps and purse seines over the period from 1981 to 1987, expressed in tons per day. The data in the Table show that, despite the increase in the number of licences in recent years, catch rates have also been increasing.

TABLE 9
CATCH RATES, TONS PER DAY

YEAR	TRAPS	PURSE SEINES
1987	8.8	18.1
1986	4.6	19.0
1985	4.6	16.4
1984	2.9	14.3
1983	3.4	18.8
1982	3.1	16.4
1981	2.9	9.4

SOURCE: NAFO SCS Doc. 88/20, Serial No. N1523

ROE EXTRACTION

NEWFOUNDLAND'S CAPELIN PROCESSING INDUSTRY

Capelin processing is a relatively new addition to the fish processing industry in Newfoundland, having developed into a lucrative business only in the 1980s. However, there were some earlier efforts to exploit the capelin resource for commercial purposes.

Appendix A contains a table of capelin landings and production values for Newfoundland taken from a report entitled, "A Long-Term Utilization Strategy for Newfoundland Capelin Resources", dated March 31, 1986, which was prepared by IDP Consultants Limited for the Department of Fisheries and Oceans. The data in the table show production, by product category, in weight and value for the period from 1953 to 1985. Until 1973, the value of production of all product forms did not come even close to $500,000. Since then, however,the value of production has been on an increasing trend.

Probably the most intense effort to develop processing activities based on capelin resulted from a 1967 conference sponsored by the Federal Department of Industry, to explore problems relating to development of the capelin resource. Work subsequent to that conference resulted in introduction of the Inshore Capelin Development Program in 1973, as a cooperative effort of the Federal Departments of Environment, Regional Economic Expansion, and Industry, Trade and Commerce with the Provincial Department of Fisheries and the College of Fisheries.

Through that Program, a variety of products were developed and subjected to consumer testing, with encouraging results. However, there has been little follow-up effort to produce and market such products. Most of the increase in value of capelin production since 1973 has been attributable to production of roe-in females for Japan.

An article in the June 12, 1976 edition of "The Evening Telegram" stated,

> "Fishery Products Ltd. is undertaking an experiment at its Catalina plant this year designed to increase the volume of caplin to be processed into fish meal and for the export market in Japan."

The article went on to describe how three Icelandic capelin seiners were to be brought in to catch capelin for both freezing and reduction. Denis Monroe was quoted as saying,

> "Special attempts will be made to get as much as possible into frozen product, namely spawn caplin for the Japanese market."

He said, as well, that other processors had attempted similar experiments with small quantities but it had been concluded that it was not possible to develop the tonnage required without an offshore catching effort.

Another article in the April 27, 1978 edition of the "Trinity Bay Compass" said,

> "A Conception Bay fish processor is expanding production to process fish roe for markets in the Far East and Europe. The expansion by Ocean Harvesters Limited of Harbour Grace should create an additional 22 jobs in their processing facility. ...
>
> The new product expansion will allow Ocean Harvesters to process roe from capelin, herring and lumpfish. ... The process includes collecting, cleaning, transferring, drying, curing, freezing and packaging of the roes.
>
> There is a strong market for this type of product, particularly as a result of Canada's 200 mile economic zone and the resulting loss by some of the Far East countries of access to fishing grounds within the zone. The capelin and herring roe will find markets in Japan and/or Korea while the lumpfish roe will go to Germany and France."

An article in the November, 1978 issue of "Fisheries Update", published by the Provincial Department of Fisheries, stated,

> "In excess of $250,000 went directly into the hands of southwest coast fishermen this past summer as a result of the Department's efforts to develop the caplin fishery in that part of the province. The Department outfitted three large vessels - all in the 100 foot range - with caplin seines and provided technical assistance in the construction of the fishing gear.
>
> The vessels, the Silver Dolphin, the Lavalee and the Canada Club, landed 6,000 metric tons (12-million lbs.) of caplin and approximately 60 tons (120,000 lbs.) of capelin roe during the period from late May to the first of July. All of the caplin was landed at the Connors Brothers processing plant at Isle aux Morts where the fish went into the reduction plant. The caplin fishery was centered mainly in the Bay of Islands with the last week of effort concentrated around Cow Head, Bellburns and Bonne Bay.
>
> During the past season two herring seiners from New Brunswick and another from Newfoundland engaged in the caplin fishery on the southwest coast and landed approximately 3,000 metric tons (6-million lbs.) of fish."

An article in a 1979 issue of "Decks Awash" magazine described developments related to capelin roe. It stated,

> "Preliminary assessments show that there's a lucrative market for this product in Japan, where the roe is used extensively for ceremonial occasions. The most popular method of packing the roe has the spawn bearing females separated from the males and packed as blocks of whole frozen fish. The other system is a little more complex.
>
> Vessels with large amounts of capelin in their holds have their hold water pumped out. The eggs are squeezed from the females by the pressure exerted by the load of capelin in the hold. These eggs are separated from the water by centrifugal force."

As well, it was observed,

> "Capelin roe is a new product in Newfoundland and market research is really just getting started in earnest. However, the field has already attracted companies such as Fishery Products, Nickerson's, Earle's, Connors Brothers, Ocean Harvesters and other smaller outfits."

Another article in a 1980 publication by the Department of Fisheries and Oceans also described developments related to capelin and capelin roe. In discussing roe, it stated,

> "A recent development has been the removal of roe from female capelin for sale in Japan. About four years ago, an Icelandic firm developed a roe processor which can be used aboard purse seiners at sea or ashore in a processing plant.
>
> Most of the operation of the processor is briefly outlined. Incoming capelin go first to a squeezing machine with a straining conveyor. Roe and water are collected in a tank. The roe is cleansed by passing through a battery of cyclones. It is frozen in blocks for shipment.
>
> At least two Canadian processing companies are making use of the newly designed processor in connection with capelin destined for reduction. As a result of the roe sales, they have been able to substantially increase the value of the fish."

From these early beginnings, a fairly substantial capelin business has been established in Newfoundland, directed at the Japanese market. However, the industry is now based on whole frozen female capelin, with no production of roe. According to the data in Appendix A, roe production peaked in 1977 at 242.4 metric tons, with a value of $1,576,400. The last year in which roe was produced was 1983.

We talked with some of the people who were involved in the early experimentation, when roe production was still being considered. Recollections related to roe are now getting to be dim but some comments did provide indications as to the reasons roe production was discontinued.

A representative of the present Fishery Products International at Catalina stated that processing of roe was discontinued when the Japanese market became flooded with the product. At that point, the specifications that had to be met became so tight that processing of the roe became uneconomical.

A representative of Earle Brothers Fisheries Ltd. in Carbonear said that part of the problem was lack of proper equipment for extracting the roe. Most of the equipment used was for washing and cleaning the roe. Apparently, capelin from small trap boats were too "fresh" to handle and much of the roe was extracted inadvertently. Capelin from Icelandic vessels that participated in the experiments were much easier to handle, presumably because they were not quite as "ripe", since they would have been caught further off from shore. The Company did have some success with roe from that source.

Apart from these reasons, it appears that roe extraction was abandoned as demand grew for whole frozen female capelin containing roe. Extraction of roe was more difficult and more costly, without the compensation of proportionately greater rewards.

According to the report by Mr. Ray Andrews referred to in the previous chapter, commercial processing of capelin for direct human consumption started in the mid 1970s and

> "occurred first in the southern part of the East Coast of Newfoundland (NAFO Area 3L) and gradually spread to the Northeast Coast and the West Coast. However, the South Coast continues to have only minimal involvement in the fishery."

Some data showing Newfoundland capelin processing plants, by NAFO area, are presented in Table 10. These data illustrate that most plants are indeed in NAFO area 3L but that most of the growth has been in other areas. They also indicate a fairly steady growth in plants both licensed and in production over the period from 1982 to 1986, even though, according to Mr. Andrews, "the Provincial Department of Fisheries decided to curtail new entrants to this processing activity in 1982."

1987 was a difficult year for capelin processing but 1988 was another good year, somewhat similar to 1986. Consequently, there has undoubtedly been some further increase recently in plants involved in processing capelin and in plants' production

TABLE 10
NEWFOUNDLAND CAPELIN PROCESSING PLANTS

YEAR	2J3K	3L	3Ps	3Pn	4R	TOTAL
LICENSED						
1986	22	62	10	2	11	107
1985	16	61	12	1	9	99
1984	18	61	11	1	7	98
1983	13	58	11	1	5	88
1982	14	55	12	1	8	90
IN PRODUCTION						
1986	17	52	7	1	5	82
1985	13	48	5	1	3	70
1984	15	47	6	0	2	70
1983	8	46	4	1	1	60
1982	10	48	5	1	3	67

SOURCE: Ray Andrews, "The Capelin Fishery - Stability in the Future"

capacity.

Again according to Mr. Andrews,

> "There is still a very real concern outside 3L that capelin processing capacity is heavily biased towards 3L. This is especially pronounced when discussing the matter with fishermen and processors in 3K. However, it should be noted that the capelin fishery had its origin in 3L."

Since capelin processing requires the end products to be frozen, freezing capacity is quite often the factor limiting any one plant's throughput. Table 11 shows the estimated freezing capacity of licensed capelin plants in metric tons per 24 hr., by NAFO area. These figures show growth of a little more than 25% over the period from 1983 to 1986. However, growth was particularly rapid in NAFO areas 3Pn and 4R combined. From the data in Table 10, it would appear that the bulk of that growth was in area 4R.

Table 12 shows the production of female capelin in the different NAFO areas from 1982 to 1986. Based on these figures and those presented in Table 11, it was possible to derive an estimate of the extent to which the freezing capacity available was actually utilized. These figures are also presented in Table 12. They show that, in general, utilization increased from 1983 to 1986, as might be expected.

However, the figures in Table 12 also show that utilization represented only about 6 to 8 days of production at capacity. Since production probably did not occur at the rated capacity of the plants, the length of the capelin processing season is probably somewhat greater than is indicated by these figures. Nevertheless, there is likely to be some scope for increasing utilization, should it be worthwhile to process capelin roe.

ROE EXTRACTION TECHNOLOGIES

Technologies have been developed in both Iceland and Norway for production of roe extracted from capelin. The Icelandic system seems to have been developed first. However, both technologies were developed considering that capelin are harvested in those countries primarily for production of fish meal and that roe is a by-product - albeit, a more valuable one.

The Icelandic system seems to be the predominant one in use, even in Norway, since the Icelandic manufacturer of the equipment has supplied it to all of the plants producing roe in Iceland, many of those in Norway - including some fishing vessels on which processing is done on-board - and one in the USSR. A copy of a brochure describing this equipment is contained in Appendix B.

TABLE 11
FREEZING CAPACITY OF LICENSED CAPELIN PLANTS
METRIC TONS/24 HR.

YEAR	2J3K	3L	3Ps	3Pn+4R	TOTAL
1986	954	2665	526	923	5068
1985	N/A	N/A	N/A	400	N/A
1984	N/A	N/A	N/A	N/A	N/A
1983	868	2247	639	290	4044
1982	N/A	N/A	N/A	275	N/A

SOURCE: Ray Andrews, "The Capelin Fishery - Stability in the Future"

TABLE 12
FEMALE CAPELIN PRODUCTION
METRIC TONS

YEAR	2J3K	3L	3Ps	3Pn+4R	TOTAL
1986	6674	21274	3552	-	31500
1985	1937	9993	1270	-	13200
1984	2620	13434	1132	614	17800
1983	830	9399	832	339	11400
1982	1448	11629	1332	91	14500

SOURCE: Ray Andrews, "The Capelin Fishery - Stability in the Future"

NUMBER OF DAYS UTILIZATION OF
AVAILABLE FREEZING CAPACITY

YEAR	2J3K	3L	3Ps	3Pn+4R	TOTAL
1986	7.00	7.98	6.75	0.00	6.22
1985	N/A	N/A	N/A	0.00	N/A
1984	N/A	N/A	N/A	N/A	N/A
1983	0.96	4.18	1.30	1.17	2.82
1982	N/A	N/A	N/A	0.33	N/A

With the system, fish and water are pumped in a mixture from the hold of a vessel to a capelin squeezer, where the roe is pressed from the capelin. A built-in straining conveyor separates the liquid containing the roe from the fish. The spent capelin are usually then conveyed to a fish meal plant for processing into meal, while the liquid containing the roe goes to a storage tank.

From the tank, the liquid is pumped to hydrocyclones, which separate the roe from the liquid, using centrifugal force. The roe then flows to another tank beneath the hydrocyclones, while the liquid can either be reused or used as blood water. From that tank, the roe is cleaned in rotating drums and flotation tanks, which separate it from any foreign matter that may have been mixed with it. Cleaned roe is then packed in cardboard cartons and frozen. An automatic filling machine may be used to fill the roe into the cartons.

Equipment to carry out the process just described can be fabricated to suit almost any scale of operation. It can also be installed either on shore or in a vessel. Iceland's roe extraction industry is land-based but on-board extraction is common practice in Norway. However, roe produced on vessels is reported to be lower in overall quality than that produced on land, apparently due to less desirable working conditions.

Although equipment can be manufactured to order, there are a few "standard" packages that can be purchased. A package with capacity to process 200 tons per hour of water and capelin combined - which should represent about 100 tons of each - was estimated by the manufacturer to cost US$100,000 FOB Newfoundland. It would require 1 person to monitor operations at the infeed end of the system and 4 to 8 people in the packing and freezing area. A simpler system with a capacity of 50 tons of capelin per hour but without the roe cleaning equipment was estimated to cost US$60,000 and to require only about 2 to 4 people, all in the packing and freezing area.

The Newfoundland companies that processed capelin roe on an experimental basis a few years ago used a version of the system outlined but did not have some of the equipment described above for cleaning the roe. As a consequence, there was often excessive dirt and foreign matter mixed with the roe and it was considered to be poor in quality.

In Iceland, roe content increases from about 14% to about 25% of the weight of female capelin over a 2 to 3 week period. It is understood that roe must represent 18% of the weight of the whole female fish before processing for extraction of the roe is permitted. However, it has not been customary to separate the females from the males prior to processing. Accordingly, roe yields from the quantity of capelin processed vary depending on both the percentage of females and stage of "ripeness" of the

roe. It was reported that, on average, a yield of about 8.5% can be expected from a given input weight containing 50% each of combined males and females.

Although a number of inquiries were made, little definitive information was obtained about the system developed in Norway. It seems that the system was developed in the late 1970s by the Norwegian Institute of Fishery Technology Research, as part of a project primarily directed at using capelin for production of composite or minced fish products. According to a verbal description of the system, it is quite different from the Icelandic system. A preliminary step for production of these products was cutting the capelin into pieces. It was found that the roe could be easily released during that step.

With the Norwegian system, fish are cut into sections using rotating knives, as a preliminary step for further processing. Roe are then released from the sections, with the carcass portions being sent for mincing or for fish meal production. The roe are cleaned, packed, and frozen in a manner similar to that described above.

Apparently, the system is more expensive to install than the one developed in Iceland. Equipment costing about US$100,000 gives a much lower rate of throughput than the Icelandic system, about 15 tons per hour. It is also said to be more sensitive to foreign matter contained in the fish. On the other hand, it gives a higher yield - an average of about 9.5% from unsorted males and females, containing 50% of each.

It is understood that these systems are manufactured by a Norwegian company, Arenco. That company is the remaining part of a larger company that used to make filleting machines in competition with West Germany's Baader company. The portion of the business involving manufacture of filleting machines was apparently taken over by Baader.

Although we made several requests to buyers of capelin roe, we did not obtain a written specification for the roe product. However, that may well be because the buying companies do not really have formal specifications. The end product consists simply of extracted roe frozen in cardboard cartons, each containing 10 kg.

ECONOMICS

In both Norway and Iceland, capelin are harvested primarily for production of fish meal. Roe-in females and extracted roe are both by-products which offer opportunities to obtain more value from the catch during the short spawning season. In Newfoundland, capelin are not presently harvested for production of fish meal. Roe-in females are our primary product and some of

the males are processed into fish meal as a by-product. Similarly, extracted roe would have to be considered a primary product here and the economics of producing it would be significantly influenced by our present use of the capelin resource.

Table 13 shows the prices paid to Newfoundland fishermen for capelin in 1988 and indicates that the price paid depends on both the content of females and the size of the fish. Size is measured in terms of the number - or count - of capelin per kilogram. Newfoundland capelin are normally in the less than 40 count category, while Norwegian capelin are normally in the 40-60 count category and Icelandic capelin are in the 55-60 category.

Based on the prices in Table 13 and the roe yield expected, it is possible to determine a raw material cost for extracted roe, expressed in C$ per metric ton of roe. Such raw material costs are presented in Table 14. It should be noted that the expected roe yields used to derive these cost figures are probably a bit optimistic, considering the Icelandic experience referred to above.

For comparison, raw material costs have also been derived in a similar manner for production of roe-in female capelin. These are presented in Table 15. As can be seen from the tables, the considerably higher yield obtained in producing roe-in females results in a much lower cost per metric ton of output.

"Upgrading" is a term used in the fish processing industry to refer to the difference between the value obtained for products sold and the cost of the raw material used to make those products. Table 16 extends on the analysis presented in Table 14 to show the upgrading that would be achieved in producing extracted roe. Two selling prices are used - US$2,450/metric ton, the price that applied in 1987, and US$1750/ metric ton, the price that applied in 1986, 1982, and 1978.

At the higher price, a positive value is obtained for most categories of capelin purchases. However, at the lower price, most categories show negative values, indicating that the cost of the raw material - without any allowance for processing costs - would be higher than the value of the roe obtained from it.

Again, for comparison, Table 17 shows the upgrading that would be achieved in using the same raw material to produce roe-in females, selling 100% females for US$1,680, the price that applied in 1988. All of the values are positive, providing margins to cover the costs of processing and contribute to overhead costs and profit.

The profitability of processing capelin for production of capelin roe is analyzed further in Table 18, using the information

TABLE 13
PRICES PAID TO FISHERMEN FOR CAPELIN, 1988
$/LB.

% FEMALE	<40	41-45	46-50
96+	0.336	0.296	0.255
90-95	0.280	0.246	0.212
85-89	0.211	0.186	0.160
80-84	0.195	0.172	0.148
75-79	0.183	0.161	0.138
70-74	0.172	0.151	0.130
65-69	0.159	0.140	0.120
60-64	0.149	0.131	0.113
55-59	0.134	0.118	0.101
50-54	0.126	0.111	0.095
45-49	0.113	0.099	0.085
40-44	0.083	0.073	0.063
35-39	0.050	0.044	0.038

SOURCE: Fishermen, Food and Allied Workers

TABLE 14
RAW MATERIAL COST FOR EXTRACTED ROE
C$/METRIC TON

% FEMALE	EXPECTED YIELD	<40	41-45	46-50
96+	0.19	3898.7	3434.5	2958.8
90-95	0.18	3429.4	3013.0	2596.5
85-89	0.17	2736.3	2412.1	2074.9
80-84	0.16	2686.9	2369.9	2039.3
75-79	0.15	2689.6	2366.3	2028.2
70-74	0.14	2708.5	2377.8	2047.1
65-69	0.13	2696.4	2374.2	2035.0
60-64	0.12	2737.4	2406.7	2076.0
55-59	0.11	2685.6	2364.9	2024.2
50-54	0.10	2777.8	2447.1	2094.4
45-49	0.09	2768.0	2425.1	2082.1
40-44	0.08	2287.3	2011.7	1736.1
35-39	0.07	1574.7	1385.7	1196.8

TABLE 15
RAW MATERIAL COST FOR FEMALE CAPELIN
C$/METRIC TON

% FEMALE	YIELD	<40	41-45	46-50
96+	0.975	759.7	669.3	576.6
90-95	0.925	667.3	586.3	505.3
85-89	0.875	531.6	468.6	403.1
80-84	0.825	521.1	459.6	395.5
75-79	0.775	520.6	458.0	392.6
70-74	0.725	523.0	459.2	395.3
65-69	0.675	519.3	457.3	391.9
60-64	0.625	525.6	462.1	398.6
55-59	0.575	513.8	452.4	387.2
50-54	0.525	529.1	466.1	398.9
45-49	0.475	524.5	459.5	394.5
40-44	0.425	430.5	378.7	326.8
35-39	0.375	293.9	258.7	223.4

TABLE 16
RAW MATERIAL UPGRADING, C$/METRIC TON
IN PRODUCTION OF CAPELIN ROE

% FEMALE	<40	41-45	46-50
SELLING ROE @ US$2,450/METRIC TON			
96+	-958.7	-494.5	-18.8
90-95	-489.4	-73.0	343.5
85-89	203.7	527.9	865.1
80-84	253.1	570.1	900.7
75-79	250.4	573.7	911.8
70-74	231.5	562.2	892.9
65-69	243.6	565.8	905.0
60-64	202.6	533.3	864.0
55-59	254.4	575.1	915.8
50-54	162.2	492.9	845.6
45-49	172.0	514.9	857.9
40-44	652.7	928.3	1203.9
35-39	1365.3	1554.3	1743.2
SELLING ROE @ US$1,750/METRIC TON			
96+	-1798.7	-1334.5	-858.8
90-95	-1329.4	-913.0	-496.5
85-89	-636.3	-312.1	25.1
80-84	-586.9	-269.9	60.7
75-79	-589.6	-266.3	71.8
70-74	-608.5	-277.8	52.9
65-69	-596.4	-274.2	65.0
60-64	-637.4	-306.7	24.0
55-59	-585.6	-264.9	75.8
50-54	-677.8	-347.1	5.6
45-49	-668.0	-325.1	17.9
40-44	-187.3	88.3	363.9
35-39	525.3	714.3	903.2

NOTE: It is assumed that US$1 = C$1.20

TABLE 17
RAW MATERIAL UPGRADING, C$/METRIC TON
IN PRODUCTION OF ROE-IN FEMALE CAPELIN

% FEMALE	<40	41-45	46-50
96+	1256.3	1346.7	1439.4
90-95	1348.7	1429.7	1510.7
85-89	1484.4	1547.4	1612.9
80-84	1494.9	1556.4	1620.5
75-79	1495.4	1558.0	1623.4
70-74	1493.0	1556.8	1620.7
65-69	1496.7	1558.7	1624.1
60-64	1490.4	1553.9	1617.4
55-59	1502.2	1563.6	1628.8
50-54	1486.9	1549.9	1617.1
45-49	1491.5	1556.5	1621.5
40-44	1585.5	1637.3	1689.2
35-39	1722.1	1757.3	1792.6

NOTE: It is assumed that US$1 = C$1.20

TABLE 18
PROFITABILITY OF PROCESSING CAPELIN
FOR PRODUCTION OF CAPELIN ROE

ASSUMPTIONS			
Raw Material Processed, Tons, @ 100 tons/hr.		750	
Roe Produced, Tons, @ 8.5% Yield		63.75	
Labour Hours Worked, 7 people x 8hr.		56	
CONTRIBUTION ANALYSIS, @ US$/Ton for Roe		2450	1750
Product Sales Value	C$	187425	133875
LESS: Product Costs			
Raw Material, 50% Female, 41-45 Count/kg.		183533	183533
Packaging, @ $0.06/kg.		3825	3825
Labour @ $10.00/hr.		560	560
		187918	187918
Contribution Margin	C$	-493	-54043
Annual Payment to Amortize an Investment of $120,000 over 10 Years @ 13% Interest			$ 22111

NOTE: Raw Material Costs are based on the schedule of 1988 prices supplied by the FFAW.

provided by the Icelandic manufacturer of equipment used for extraction and processing of the roe. The analysis is for one shift of production using the equipment for which a cost estimate was provided. It shows that, even if roe could be sold for US$2,450 per metric ton - the highest price it has been sold for - there would be a loss. At a selling price of US$1,750 per ton, a more normal price level, the loss would be even greater.

Based on the analysis in Table 18, it seems fair to conclude that the principal factor inhibiting profitable operation is the cost of the raw material, since the costs of packaging, labour, and amortization of the processing equipment are almost insignificant relative to the value of the roe that would be produced. Because the base prices for capelin in Norway and Iceland are determined considering that capelin are harvested on a large scale, by large vessels, and are used for production of fish meal, the calculation shown in Table 18 would likely be quite different in those contexts.

For example, if the price paid for the capelin were $0.06 per lb., instead of about $0.11, the raw material cost would be $99,207. In turn, that would result in contribution margins of C$83,833 at a selling price for roe of US$2,450 and C$30,283 at a selling price of US$1,750. These margins would make roe extraction a very attractive proposition. It is understood that, at least in Iceland, fishermen do obtain some extra reward for their effort, when their catch is used for production of roe. However, the extra payments would not be enough to make the raw material as expensive as it is in Newfoundland.

A couple of other observations can also be made on the basis of the analysis in Table 18. These are as follows:

1. production would be at a very large scale using a production system with a throughput capacity of 100 tons of capelin per hour, requiring a very large refrigeration system to be available for freezing the extracted roe; and

2. 100 shifts of production for systems such as that used for the analysis in Table 18 would supply the entire Japanese market in a year when demand is reasonably "normal", leaving room for only a few systems, if the production season is 10 days long.

Despite the seemingly limited opportunity for production of capelin roe, the Icelandic manufacturer of these production systems claims to have supplied a total of 40 over the period from 1978 to 1987. Of these, 18 were in Iceland, 21 were in Norway, and 1 was in the USSR. Eighteen of the systems installed in Norway and the one system installed in the USSR were put on fishing vessels, while the others were installed on land.

A STRATEGY FOR DEVELOPMENT

THE MARKET OPPORTUNITY

From the foregoing discussion, it seems that Japan would be the most likely market on which to base development of a capelin roe fishery in Newfoundland, because of the large overall size and rapid growth of that country's demand for roe products. Furthermore, capelin roe is a known product in that market and it has had some success at different times in the past.

On the other hand, the potential for Newfoundland suppliers to enter the Japanese market for capelin roe is presently not very good. A significant part of the problem seems to be that capelin roe is not well established as a product in its own right but is generally seen either as a lower-cost substitute for other, more accepted and more valuable roe products or as an ingredient in formulated products. Consequently, demand is a function of

- the availability and prices of the products for which capelin roe is a substitute, and/or

- the success of efforts to develop products in which capelin roe would be a satisfactory ingredient.

At the present time, ready availability and reasonable cost of herring roe are having a negative influence on demand for capelin roe, while there seems to have been very limited success in development of products to help establish capelin roe as a unique product. If entry to the market is to be attempted at all, it would have to be in recognition of the limited demand and low prices expected, at least for the short term.

However, considering that overall demand for roe products in Japan has been growing fairly rapidly, it may be possible that the market there will be more receptive in the future, particularly if a way can be found to change the way in which consumers have traditionally viewed capelin roe. A question worthy of consideration is whether or not trying to find such a solution is likely to be a worthwhile venture for Newfoundland-based organizations to undertake on their own. It is doubtful that any local companies would be motivated to become involved now, so any initiative is likely to require substantial input from the public sector.

One advantage Newfoundland suppliers may have in trying to obtain a share of the market for capelin roe is that our capelin are larger and the size of the roe is probably larger, as a result. Since virtually all of the capelin roe that has been marketed in Japan has come from the smaller capelin harvested in Europe and in the Pacific region, it is possible that Newfoundland capelin roe may be a more acceptable product. Apparently, Japanese consumers are now showing a preference for the larger Newfoundland female capelin over the smaller European variety,

even though they preferred the smaller ones in the past.

A significant disadvantage for potential Newfoundland entrants to the market is that the capelin fisheries in Norway and Iceland occur earlier in the year than the fishery in Newfoundland. Consequently, we could become residual suppliers to the market, with demand being good for our products only if the European fisheries are not successful.

RESOURCE POTENTIAL

There seems to be little doubt that Newfoundland's capelin resource can support a greater degree of exploitation for commercial purposes. Biological advice on allowable catches is considered to be conservative, in that larger catches probably would not endanger the stocks. Nevertheless, actual Total Allowable Catches that have been set by managers of the resource, primarily on the basis of market considerations, have been lower than would be allowable, if the biologists' advice had been followed. Furthermore, actual catches have generally been lower than the fishing quotas set by the resource managers.

On the other hand, harvesting capelin for extraction of roe could result in very substantial utilization of the resource. For example, production of 5,000 tons of roe would require harvesting over 58,800 tons of capelin, if the roe yield is 8.5%. That would be more than has been harvested in most years for production of roe-in females.

Furthermore, harvesting at such a level could contribute to a considerable problem. If only 8.5% of the input weight will be used for roe, that leaves 91.5% - representing the male capelin and the carcasses of females from which roe are extracted - to be used for something else or to be disposed of. It would be ideal to have an alternative use for this material but such an alternative does not seem to exist right now.

The obvious potential use is for production of fish meal but Newfoundland does not now have a large or well-equipped fish meal industry. A study done recently indicated that there might be some potential for use of capelin in production of surimi. That study, entitled "Production and Quality Assessment of Surimi from Selected Atlantic Groundfish and Male Capelin" was undertaken for the Fisheries Development Division of Fisheries and Oceans Canada in the Newfoundland Region.

Considering the substantial benefits now being obtained from exploitation of the capelin resource for production of roe-in females and the lesser benefit from production of roe, any effort to harvest additional capelin for production of roe should not interfere in any way with the fishery for production of females. Consequently, capelin harvested for roe production should be

taken only

- after quotas for production of female capelin have been filled, or

- in areas that cannot participate in production of female capelin.

Another approach might be to develop other activities around the capelin resource - such as a stronger fish meal industry or production of surimi - and view extraction of roe as a potentially valuable by-product. A number of efforts have been undertaken in the past to develop a variety of capelin products for sale in different markets, with promising results. The report entitled, "A Long-Term Utilization Strategy for Newfoundland Capelin Resources", which was referred to earlier, reviewed many of these efforts. Despite the apparently promising initial results of some of the efforts at product development, nothing much seems to have come of them.

CAPACITY FOR HARVESTING AND PROCESSING

There appears to be ample capacity available for harvesting the capelin resource. Table 19 shows one calculation of that capacity, under particular assumptions. According to the data in the Table, the currently available quotas could be caught in only a day or two of fishing in some areas. Consequently, the presently existing capacity must be underutilized.

Considering the economics of roe production, the question to be addressed is whether or not capelin can be harvested and delivered for processing at a substantially lower cost than it is now for production of roe-in females. It cannot be, if the prices paid to fishermen that prevailed in 1988 continue to apply. Lower prices will be needed. That is one particularly good reason for ensuring that any harvesting effort for roe production be kept quite separate from the effort for production of roe-in females.

There is presently no capacity in Newfoundland for production of capelin roe. Although there is freezing capacity that could be used to freeze the product, there is no capacity for extracting the roe from the capelin and cleaning it. Consequently, if such capacity is to be established, investments will have to be made. Given the present uncertainty over markets and the high cost of the raw material, it is highly unlikely that a private sector company would invest in the equipment needed for production of roe.

As was indicated by the Japanese buyer whose input was referred to earlier, any attempt to go into production of capelin roe is likely to be on an experimental basis only, with a large amount

TABLE 19
CAPELIN HARVESTING CAPACITY, TONS PER DAY
BY NAFO AREA

	2J	3K	3L	3Ps	4R	TOTAL
LICENCES						
Fixed Gear	15	1066	973	147	331	2532
Mobile Gear	0	78	150	5	18	251
CATCHING CAPACITY						
Fixed Gear	132.0	9380.8	8562.4	1293.6	2912.8	22281.6
Mobile Gear	0.0	1411.8	2715.0	90.5	325.8	4543.1
Total	132.0	10792.6	11277.4	1384.1	3238.6	26824.7

NOTE: It is assumed that 1 fixed gear licence = 1 trap, that 1 mobile gear licence = 1 purse seine, and that the catch rates are as shown in Table 9 for 1987.

of financial assistance from government.

APPENDIX A - CAPELIN LANDINGS AND PRODUCTION VALUES, NEWFOUNDLAND 1953-85

Table 6.19: Capelin Landings and Production Values, Newfoundland 1953-85

	Landings		Fresh		Frozen		Frozen Roe		Smoked/ Dried/Corned		Canned	
			Round	Dressed	Round	Dressed						
	MT	$(000)	MT	$(000)	MT	$(000)	MT	$(000)	MT	$(000)	MT	$(000)
1953	14,623.1	122.4	102.5	2.3	146.1	3.2	-	-	96.6	21.3	-	-
1954	14,388.1	158.6	107.9	2.4	-	-	-	-	120.9	26.6	-	-
1955	13,903.5	153.1	108.4	2.4	-	-	-	-	7.4	1.6	-	-
1956	13,824.8	152.4	108.1	2.4	-	-	-	-	44.1	9.7	-	-
1957	11,950.0	149.1	125.5	2.8	-	-	-	-	171.0	37.7	-	-
1958	9,921.8	131.8	113.4	2.5	32.1	7.0	-	-	239.7	52.9	-	-
1959	6,238.0	103.2	90.7	2.0	79.1	14.0	-	-	366.8	80.9	96.2	27.6
1960	7,011.9	107.9	113.4	7.5	34.5	10.1	-	-	270.5	68.6	129.5	39.1
1961	5,204.6	87.6	116.6	9.0	45.4	13.4	-	-	337.2	85.5	71.9	21.8
1962	4,448.0	75.0	116.6	9.0	12.4	3.4	-	-	277.0	70.2	-	-
1963	5,372.0	101.2	116.6	9.0	20.1	5.5	-	-	199.7	50.6	-	-
1964	4,874.7	97.2	116.6	9.0	9.1	2.5	-	-	194.2	49.2	-	-
1965	4,781.4	86.0	-	-	171.5	47.3	-	-	158.1	40.1	-	-
1966	4,846.0	93.4	-	-	32.2	8.9	-	-	156.0	39.5	-	-
1967	3,454.5	61.9	-	-	73.7	20.3	-	-	120.0	30.4	-	-
1968	3,312.6	65.0	-	-	81.2	21.5	-	-	106.5	24.2	-	-
1969	3,450.1	57.0	-	-	123.9	32.8	-	-	139.0	36.7	-	-
1970	3,339.4	69.0	-	-	110.6	28.0	-	-	0.2	-	-	-
1971	2,516.6	49.4	-	-	110.0	29.0	-	-	6.4	2.1	-	-
1972	4,366.8	73.2	55.6	22.1	59.1	19.5	-	-	133.2	53.9	-	-
1973	6,597.2	293.4	27.3	19.1	550.0	321.3	-	-	62.1	36.7	-	-
1974	15,384.6	568.0	53.7	37.9	550.6	270.1	-	-	114.7	144.2	0.1	0.3
1975	4,589.4	130.2	55.9	36.2	380.8	240.0	-	-	111.8	145.4	-	-
1976	9,612.7	286.4	129.1	84.8	472.2	302.9	41.9	267.7	92.7	122.6	-	-
1977	13,472.9	587.6	184.6	121.3	606.2	459.7	242.4	1576.4	82.9	117.5	-	-
1978	18,252.4	1121.7	5.5	3.7	1,633.6	1,112.8	121.3	802.2	12.3	18.5	0.1	0.4
1979	18,798.0	1960.1	0.3	0.1	3,527.0	4,222.2	30.9	74.8	43.4	57.7	-	-
1980	20,637.8	3217.0	35.0	18.0	7,708.0	10,874.9	1.0	0.8	52.0	112.4	3.0	15.2
1981	28,558.0	4750.0	142.0	37.7	11,315.0	18,209.4	-	-	10.0	20.4	-	-
1982	31,601.0	6932.0	47.0	12.5	15,166.0	26,213.9	-	-	-	-	3.0	12.0
1983	29,836.0	5606.0	46.0	12.1	11,854.0	16,019.3	8.0	9.8	2.0	4.6	3.0	14.0
1984	49,199.0	8983.0	27.0	7.2	18,862.0	30,839.8	-	-	22.0	50.5	11.0	50.2
1985	31,158.0	5100.0	*	*	14,122.0	*	-	-	1.0	*	3.0	*

	Breaded/ Cooked		Total Food		Bait/ Fertilizer		Meal			Oil		Total Processed
	MT	$(000)	MT	$(000)	MT	$(000)	MT Actual	MT Converted	$(000)	GAL	$(000)	$(000)
1953	-	-	345.2	26.8	14,234.2	188.3	-	-	-	-	-	215.1
1954	-	-	228.8	29.0	14,098.9	161.4	-	-	-	-	-	190.4
1955	-	-	115.9	4.0	13,675.8	152.2	-	-	-	-	-	156.2
1956	-	-	152.2	12.1	13,659.8	163.0	-	-	-	-	-	175.1
1957	-	-	296.4	40.5	11,568.1	141.1	-	-	-	-	-	181.6
1958	-	-	385.2	62.4	9,416.7	129.8	-	-	-	-	-	192.2
1959	-	-	632.9	124.5	5,332.1	78.0	-	-	-	-	-	202.5
1960	-	-	547.9	125.3	6,258.5	190.4	-	-	-	-	-	315.7
1961	-	-	571.0	129.7	4,267.3	144.7	-	-	-	-	-	274.4
1962	-	-	406.0	82.6	3,902.9	130.0	-	-	-	-	-	212.6
1963	-	-	336.4	65.1	4,935.8	167.7	-	-	-	-	-	232.8
1964	-	-	319.9	60.7	4,457.8	136.9	-	-	-	-	-	197.6
1965	-	-	329.6	87.4	3,184.7	102.4	-	-	-	-	-	189.8
1966	-	-	188.2	48.4	3,672.6	113.8	-	-	-	-	-	162.2
1967	-	-	193.8	50.7	2,202.8	62.6	-	-	-	-	-	113.3
1968	-	-	187.7	45.7	2,709.5	93.7	-	-	-	-	-	139.4
1969	-	-	262.9	69.5	2,348.0	80.0	-	-	-	-	-	149.5
1970	-	-	110.8	28.0	1,285.2	34.4	-	-	-	-	-	73.3
1971	-	-	116.8	31.1	995.2	25.9	50.0	480.0	10.9	*	*	79.4
1972	-	-	247.9	94.5	830.7	30.4	126.0	1,008.0	22.4	*	*	124.9
1973	0.9	1.3	640.4	378.4	771.2	28.9	*	*	*	540.0	0.5	576.3
1974	0.7	0.9	719.8	423.4	967.7	47.7	487.0	3,893.0	168.5	56,305.0	102.5	1,191.8
1975	1.2	1.8	549.6	473.4	679.7	84.6	1840.0	14,720.0	618.2	3,694.0	5.2	560.5
1976	-	-	735.8	778.0	372.3	51.5	182.0	1,456.0	47.3	-	-	1,085.4
1977	-	-	1,116.0	2,274.9	288.8	48.5	1032.0	8,256.0	255.9	12,592.0	23.3	2,509.9
1978	-	-	1,772.7	1,937.6	242.5	40.3	480.0	3,840.0	163.2	100,906.0	213.9	2,851.4
1979	-	-	3,601.5	4,354.8	72.6	13.9	1778.0	14,224.0	659.6	116,000.0	272.6	5,301.1
1980+	-	-	7,799.0	11,021.3	151.0++	29.4	1550.0	12,400.0	660.3	95,638.0	146.3	11,505.1
1981	-	-	11,467.0	18,267.5	427.0	82.1	738.0	5,904.0	308.1	29,500.0	*	*
1982	-	-	15,216.0	26,238.4	475.0	94.8	348.0	2,784.0	*	-	-	26,333.2
1983	-	-	11,913.0	16,059.8	403.0	68.6	-	-	-	-	-	16,128.4
1984	-	-	18,922.0	30,947.7	668.0	164.4	-	-	-	-	-	31,112.1
1985	-	-	14,126.0	*	*	*	-	-	-	-	-	*

Notes: + Figures for 1980 and beyond rounded to nearest thousand.
++ Figures represent fresh and frozen bait only. Fertilizer not included.
* Not Available
- No Production

Source: DFO Statistics

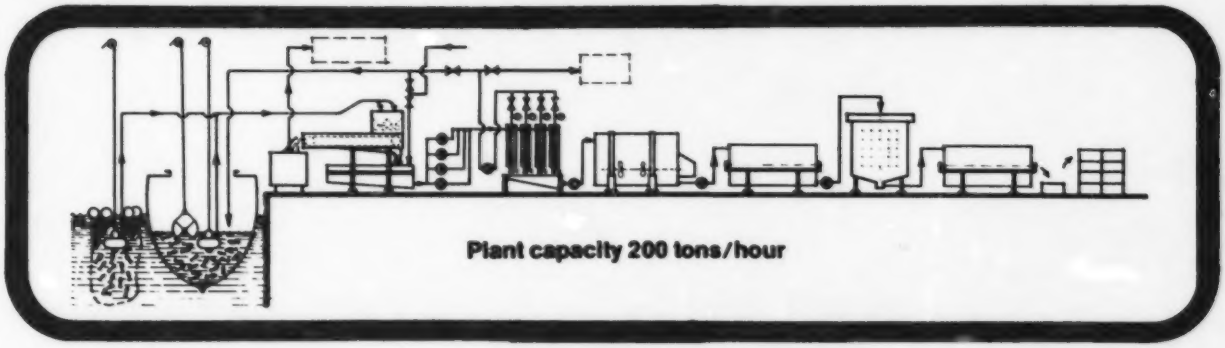
APPENDIX B - BROCHURE DESCRIBING ICELANDIC SYSTEM FOR ROE EXTRACTION

TRAUST hf

BOX 4413 - REYKJAVÍK - ICELAND - PHONE: [illegible] - TELEX 3010

Machinery for processing of capelin roes

Patented



Plant capacity 200 tons/hour

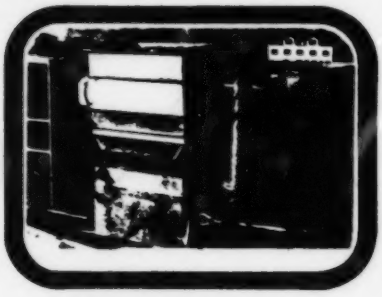
This equipment is for the extraction, separation, cleaning, weighing, packing and preserving of roes from capelin. The plant can be purchased as a whole or as separate units.

This processing increases the value of the catch tremendously as compared to processing it into fish meal. The equipment can be installed aboard purse seiners, on the quay or at the freezing plant.

The equipment can be tailored to the needs of individual producers.

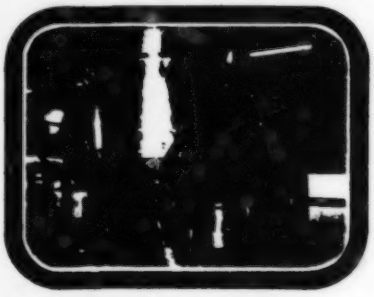
The capelin season is rather short and the quantity of roes that can be gathered depends on the ratio of the sexes in the catch. The yield increases as spawning approaches. A yield of 6—10% of the catch as roes is common when the percentage of female capelin is 50%. The highest possible yield with 50% female capelin in the catch is 12—13%.

The flow sheet above shows the processing line for roes from capelin. Fish mixed with water is pumped into the capelin squeezer where the roes are pressed from the capelin. Built in sea-water separator separates most of the liquid immediately from the capelin. Special straining conveyor separates the liquid containing the roes from the fish which then goes to the holds of the ship or the fish meal factory. The liquid goes to a storage tank from which it is pumped to hydrocyclones which separate the roes from the liquied. The roes then flow into a tank beneath the hydrocyclones. The liquid is reused in part for mixing with the fish while what is left goes into the sea or is used as blood water if the catch is being landed. The roes are then cleaned in special rotating drums and flotation tanks. At this stage the roes are weighed into cardboard boxes and frozen.



Capelin press on shore.

Capelin press on board



Floatation tanks in plant.

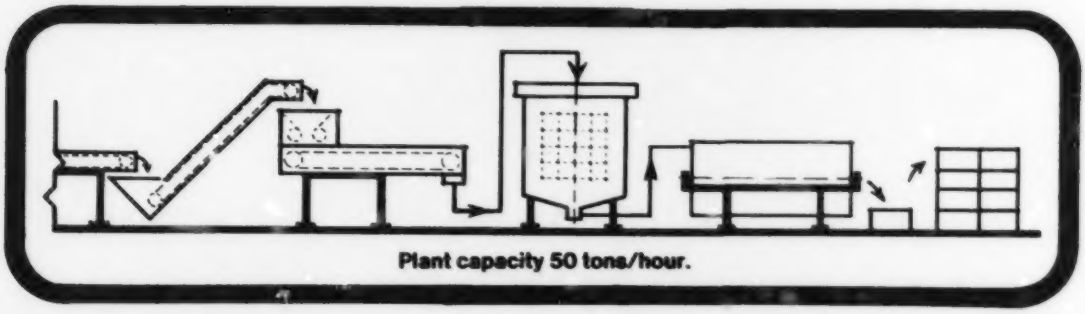
The straining conveyor is made from a net of stainless steel. This type of net allows for better separation. It also clears itself well.

The capelin squeezer can be adjusted such that fish up to 70mm (3in) flows through without hindrance.

TRAUST Ltd has gained extensive experience in the processing of roes from capelin over a number of years. Improvements are constantly being made as well as new developments.

TRAUST Ltd has manufactured a great number of machines for extraction of roes from capelin which have been used with good result in Iceland, Norway, Canada and Russia.

The export value of roes from capelin is 30 times greater than if they were processed into fishmeal. Machinery from TRAUST Ltd for extraction of roes from capelin helps to maximize the gain to be made from the catch and therefore is a very profitable investment.



Plant capacity 50 tons/hour.

This system works on the same principle as our large capacity capelin roe extraction plant. The capelin from conventional grading machines is pressed, washed and drained. The liquid containing the roes goes to a cleaning, washing and drying machine.

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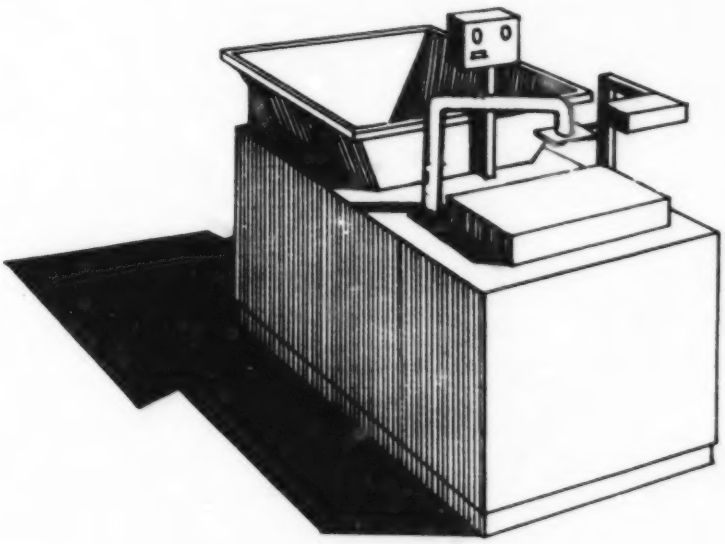
BOX 118 – REYKJAVÍK – ICELAND
PHONE 91–26155 – TELEX 2074.

AUTOMATIC FILLING MACHINE AUM 95



Capelin roe are extremely difficult to dose and weighing and packing take much time. This machine is constructed to dose capelin roe.
The machine doses by weight but not volume and is therefore valuable when dosing f. ex. roe because of its high accuracy and the high value of the roe.

Main Advantages:

- Can be used for most liquid and pasty media as f. ex. fish roe.
- Electronic weighing instrument makes the portions by weight but not by volume.
- Easy to vary the quantity of the portion.
- Accuracy of ± 0.25% can be reached.
- Takes little space and the filling gun can be placed away from the feeding station.
- Special pump which does not dammage the pasty media.
- Material is stainless steel, aluminum and plastic.
- Easy to clean.
- 100 litre stainless steel hopper.

Operation:

- The empty carton is placed upon the scale.
- The switch is pressed to start the feeding and open the nozzle.
- The product will be pumped into the carton until the weight required is reached.
- The scale operates a switch which shuts off the filling gun instantaneously.
  The cycle is repeated.

Technical data:

Length mm (in): 1500 (59)
Width mm (in): 720 (28)
Height mm (in): 680 (27)
Required power: 4.0 kW
Air consumption: 50 liters/min. at 6kp/cm² pressure
Capacity: kg/h (lbs/h): ca. 3600 (800)
Accuracy: ± 0.25%
Weight kg (lbs): 215 (473)

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